CHAPTER

3

Drawing With a Computer

This chapter provides general instructions for making drawings with a computer. Because there are many different types of computers available, each capable of running many different drawing programs, we cannot provide complete instructions on drawing with a computer: You must rely on the user's manual of your drawing program. Nevertheless, since most drawing programs work in similar ways, we can provide you with a good idea of the necessary equipment and software, how they are used, and the impressive results you can achieve.

CAUTION

If you need help with using a computer or software, please call the computer or software vendor. Neither Nolo nor the authors can provide such help.

Necessary Equipment and Software

As you are probably aware, a computer includes two distinct elements: equipment (hardware) and software. The hardware includes a processor, a monitor or display screen, a keyboard, a mouse, and other physical components. Software includes an operating system, such as Windows or Mac OS, that controls the basic functioning of the computer, and application programs, such as word processors and drawing programs, that allow you to do useful work.

Bitmap Painting Programs

There are two primary types of drawing programs: bitmap and vector. Bitmap programs, also known as image editing programs, manipulate bitmapped images, which are made up of individually controllable pixels or dots. Microsoft *Paint*, which comes with Windows, and Adobe *Photoshop*, by Adobe Systems Inc., are examples of image editing programs. Because they are mainly designed for editing photographs or making artistic renderings, image editing programs are unsuitable for making patent drawings. However, they are useful in a particular method, discussed in Chapter 7, for making design patent drawings.

Vector Drawing Programs

Vector drawing programs manipulate lines that are defined by spaced-apart points, like connect-the-dots drawings. The lines can be edited by moving the points. There are two main types of vector drawing programs: graphic design and CAD (computer-aided drafting or design). *CorelDraw*, Adobe *Illustrator*, and *Freehand* are examples of graphic design programs. Such programs are primarily designed for drawings with color-filled areas, such as those used in brochures and magazine ads. Their tools (functions) are not designed for making line drawings, such as patent drawings. Although they can be used to make patent drawings, most are not very good at the task. There are some exceptions, such as programs for making drawings of graphical symbols such as flowcharts. Besides dedicated flowchart programs, Microsoft *Word* and *PowerPoint* can also make flowcharts.

CAD Programs

CAD programs are especially designed for making engineering drawings, which are dimensionally accurate line drawings, so they are the type of drawing program that is most suitable for making patent drawings. CAD programs are further divided into 2D (two-dimensional) and 3D (three-dimensional) programs.

Two-Dimensional (2D) CAD Programs

Drawings done in a 2D program are simply computerized versions of paper drawings, so they do not include depth information. Each view or figure must be drawn separately. Creating a 2D CAD drawing is roughly similar to making a drawing on paper, except different tools are used in the process. However, even a 2D CAD program has huge advantages over traditional ink drawing techniques: It allows you to construct drawings more easily and with greater precision, and it allows you to edit (modify) them with great ease.

The interface (computer screen display) of a typical 2D CAD program is shown in Illustration 3.1, and includes the following important elements:

- the workspace or drawing area
- tool buttons that may be clicked to perform operations
- a movable cursor for setting points, pressing tool buttons, selecting drawing objects, and so on, and that is controlled by a mouse, and
- coordinate displays that show the position of the cursor in terms of its horizontal (X) position and vertical (Y) position relative to a reference point. The cursor may be moved a specific distance by dragging it until the desired coordinates are displayed, or by typing the desired X and Y positions in the coordinate displays.

Some 2D programs are listed later in this chapter.

Three-Dimensional (3D) CAD Programs

Drawings done in 3D CAD programs are three-dimensional representations of actual objects. Although a drawing can be visualized in only two dimensions on the monitor screen and printed output, the drawing file includes the information that describes an object in three dimensions. Because creating a 3D drawing is equivalent to building a model of your invention in cyberspace (computer-generated world), such drawings are also called 3D models. A 3D CAD model can be rotated for viewing from any angle, sliced apart to show interior parts, and disassembled, just like the real thing. Thus, the main advantage of 3D drawings is that, by making only one 3D drawing of your invention, you can get a variety of 2D views out of it with great ease and print them as patent drawings.

The interface of a typical 3D CAD program is shown in Illustration 3.2, and includes the following important elements:

- the workspace, which is the drawing area. The particular program shown has four views of the workspace: the main view on the right being a perspective view, and the three views on the left being (from top to bottom) front, top, and side views.
- tool buttons that may be clicked to perform operations
- a cursor for setting points, pressing tool buttons, selecting drawing objects, and so on. The different views clearly show the exact position of the cursor in relation to the drawing object, so that additional objects may be created at precise positions with respect to the object.
- coordinate displays that show the position of the cursor in terms of its horizontal (X) position and vertical (Y) position relative to a reference point, as well as its depth (Z) position in front of or behind the reference point. The cursor may be moved a specific distance by dragging it until the desired coordinates are displayed, or by typing the desired X, Y, and Z positions in the coordinate displays.

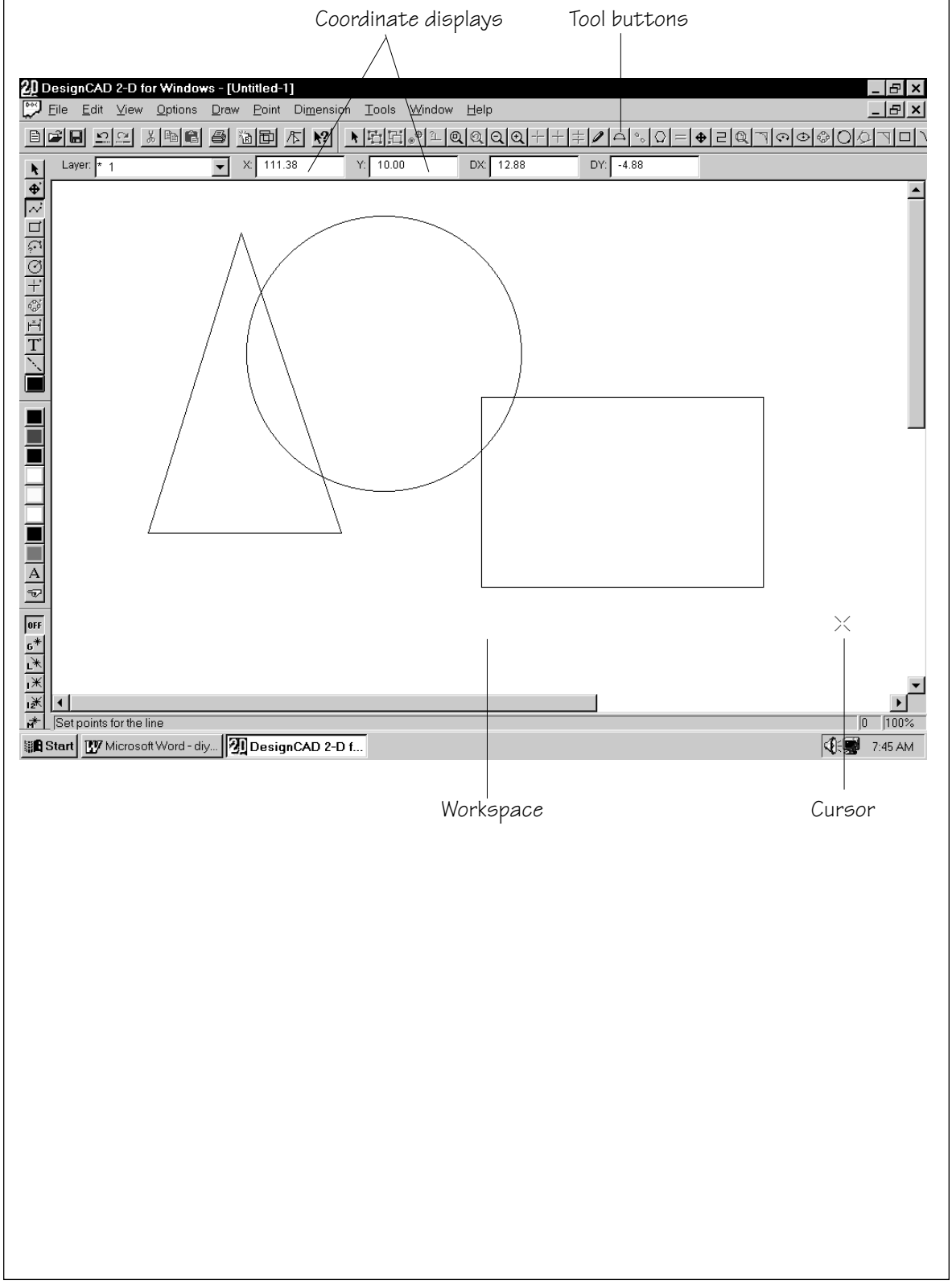


Illustration 3.1—2D CAD Interface

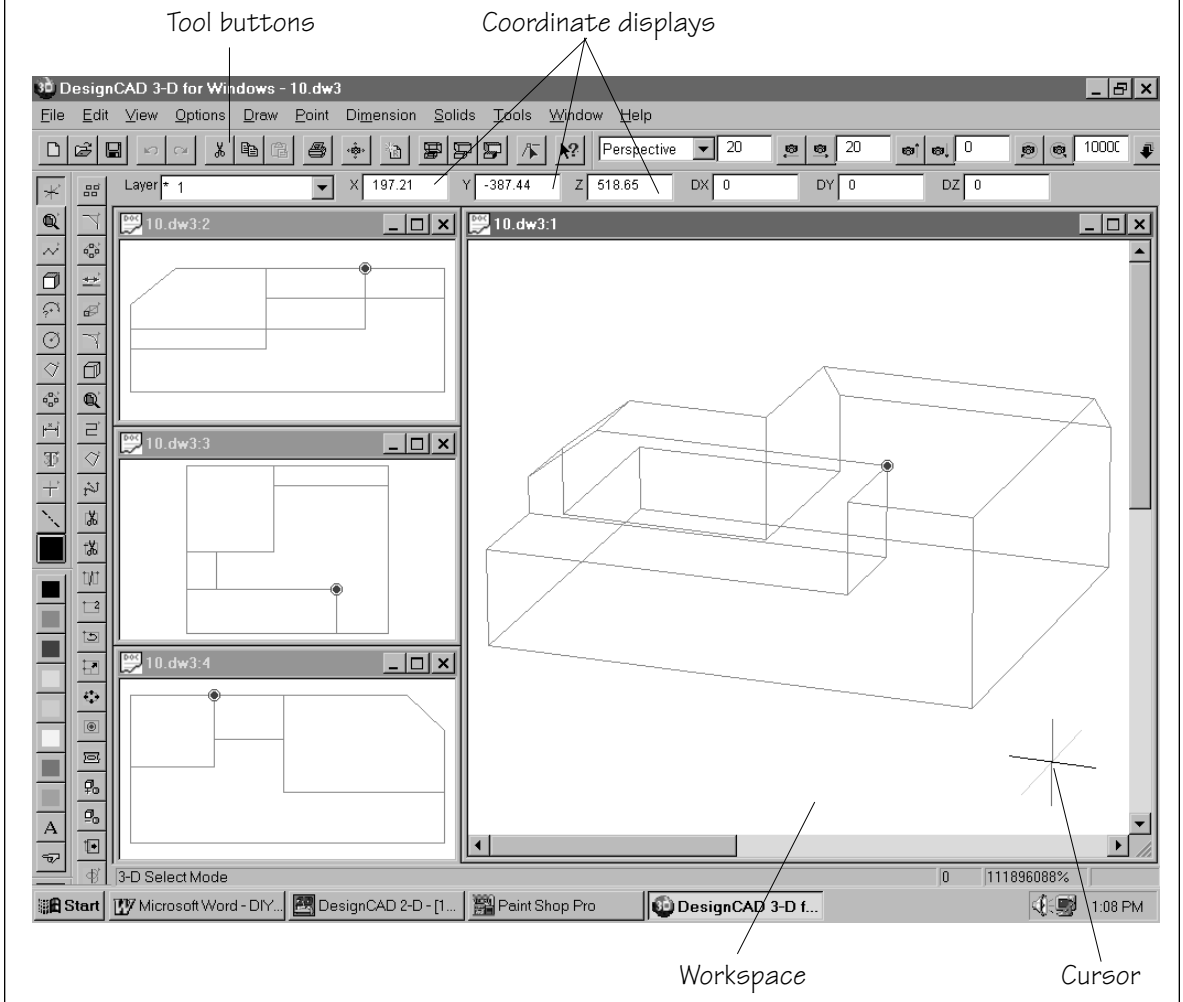


Illustration 3.2—3D CAD Interface

2D Necessary for Doing 3D

While some low-cost CAD programs are 2D only, some are 3D only, and some are both. A 3D-only program lacks the editing tools necessary to turn drawings into final form, so it must be used in conjunction with a 2D program. In that case, the 3D drawing must be converted into 2D format and imported (loaded) into a 2D program for editing, which is inconvenient and may not function due to incompatibility problems—particularly if the programs are from different publishers. Therefore, it is best to use a program with both 2D and 3D capabilities. Nevertheless, there are good programs that are either 2D only or 3D only. If you like a program that is 3D only, it is best to get a 2D program from the same publisher to ensure compatibility.

Charting and Schematic Programs

Most graphic design programs, in addition to being able to make line drawings of objects, are also capable of making flowcharts, electronic schematics, and other drawings of graphical symbols. As discussed earlier, there are also specialized programs that are even more capable of making drawings of such charts, schematics, and symbols. If you want to draw graphical symbols as well as physical objects, you should try a CAD program first to see if it is adequate. If you are interested only in drawing graphical symbols, or if you plan on making many such drawings, you should consider using a program specialized for such symbols.

List of Software

The following inexpensive programs are perfectly suitable for making patent drawings of simple inventions. They are available through the online stores of their publishers and through many other online retailers.

As a very rough general rule, the more expensive programs are more capable. However, for most patent drawings, the inexpensive programs suggested here are adequate. Each of these programs has its strengths, weaknesses, and even bugs (problems). Some publishers offer downloadable free trials or demos on their websites, so try before you buy. For other programs without demos, try to find reviews of these programs on the websites of computer magazines.

You can find some reviews at CAD-Reviews (www.cad-reviews.com), CADInfo (www.cadinfo.net), and Digital CAD (www.digitalcad.com).

Autosketch

Functionality: Use to create 2D drawings.

Compatibility: Windows XP, Vista, Windows 7

Price: about $250

Website: www.autodesk.com

Note: From the maker of AutoCAD. File format compatibility with AutoCAD.

DesignCAD

Functionality: Use to create 2D drawings.

Compatibility: Windows XP, Vista, Windows 7

Price: about $50

Website: www.imsidesign.com

Note: Easy to use. File format compatibility with AutoCAD.

DesignCAD 3D Max

Functionality: Use to create 2D and 3D drawings.

Compatibility: Windows XP, Vista, Windows 7

Price: about $100

Website: www.imsidesign.com

Note: More powerful and still relatively easy to use.

SmartDraw

Functionality: Use to create flow diagrams and block diagrams.

Compatibility: Unspecified

Price: About $200, downloadable free trial

Website: www.smartdraw.com

Note: Not for making line drawings.

TurboCAD

Functionality: Use to create 2D and 3D drawings.

Compatibility: Windows XP, Vista, 7

Price: About $300 for Windows version, $200 for Mac version

Website: www.turbocad.com

Besides these inexpensive programs, you can also try the free CAD programs listed on these web sites:

- www.freebyte.com/cad/cad.htm, and
- www.techsupportalert.com/best-free-cad-program.htm.

In addition to the above CAD programs, more expensive CAD programs are available. These are mainly used by professionals and their price and learning curve is not usually justified unless you expect to do many patent drawings or unless you have access to a computer which contains one of these programs. Two of the professional CAD programs are *Canvas 12* (about $600) and *AutoCAD* (about $4000).

CAUTION

The above list of software is provided for your convenience. Nolo and the authors do not endorse any of these products and have not tested them, except for an early version of *DesignCAD*.

Computers

Most CAD or flowchart programs are made for PCs with Microsoft Windows XP, Vista or Windows 7. The less expensive programs have relatively low system requirements and run easily on virtually any personal computer with these operating systems. A few programs, such as *TurboCAD*, are available in separate Mac versions. Keep in mind that a program may run under the minimum requirements established by the manufacturer, but the performance is usually sluggish and exasperating because the system resources are strained. Fortunately, most new PCs exceed these specifications.

Printers

A printer is necessary for putting your drawing on paper. Inkjet printers produce satisfactory patent drawings if you use high quality inkjet paper. (See Chapter 8 for details on inkjet papers.) Only color inkjets with a separate black ink cartridge have the potential to produce the truly black output required by the PTO. (**Note:** Dot matrix printer quality is considered unacceptable by the PTO.)

The PTO sometimes objects to drawings produced by inkjets (even those with a separate black cartridge) as not being black enough or sharp enough. This problem can be avoided by submitting a photocopy of the printer output. Any inkjet with a separate black cartridge that prints at 600 dpi (dots per inch) or higher is suitable for outputting black line drawings. The PTO no longer accepts photos for patent drawings (except for photomicrographs). However, if you need to print any photographic images, a higher resolution inkjet is required, such as one of the Epson Stylus Photo line of printers. Expect to pay $200 or more for a photo inkjet printer.

Tips on Buying a New Computer

Keep in mind:

- All computers become obsolete in a few years, so getting the fastest one available will ensure that you will get the longest useful life out of it.
- A computer with mid-level performance will generally give you the most bang for the buck.
- Most PC vendors, whether big or tiny, do not really manufacture their computers. Instead, they purchase most or all of the snap-together components from the same pool of component manufacturers and simply assemble them. Therefore, there is generally no correlation between name/price and performance/reliability. However, there may be a difference in technical support—that is, how helpful they are in answering your technical questions after you buy a computer.
- Read computer magazines, such as *PC World*, *Smart Computing*, or Walter S. Mossberg's column archive at http://ptech.wsj.com/archive.html for the most up-to-date equipment and software recommendations, and rankings of PC vendors on technical support performance.
- Computer superstores (online and off) have the largest selection of products and offer flexibility in modifying the components. Consumer electronics and office supply stores also sell computers, but their selections are usually limited to certain brands, and the models cannot be reconfigured. Computers by name-brand vendors, such as Compaq, Dell, and Gateway, are usually safe choices.

Low-cost laser printers that print at 600 to 1200 dpi output produce suitable quality patent drawings. Do not use older 300 dpi laser printers since PTO examiners and drawing inspectors sometimes object to their output as being too rough. Expect to pay approximately $200 or more for a typical 600 to 1200 dpi laser printer.

Peripherals

Optional peripherals (add-on components) can expand your computer's capabilities and make drawing easier. These peripherals include:

- a digital camera for taking pictures of your invention and transferring the images to a computer for tracing in a CAD program. Higher resolution cameras produce sharper images with more details for easier tracing. The minimum recommended resolution is 4 megapixels. An optical zoom lens is a must for sharpness. Avoid phone and pocket cameras with digital-only zoom that produce blurry images.
- a flatbed scanner for scanning photographic prints of your invention for tracing in a CAD program. A digital camera is far better, but if you already have a film camera and do not plan to get a digital camera, a scanner may be used to transfer the photos into the computer. The Canon CanoScan series are very inexpensive and easy to use. Scanners cost roughly $50 to $200.

Total Cost

If you are buying everything new, the total cost of a computer setup can vary tremendously, from $1,000 to sky's-the-limit, depending upon the number and caliber of components you get. Although the cost is higher than a set of traditional drawing tools (see Chapter 2), a computer may be used to perform a

variety of other tasks in addition to making drawings, including writing your patent application, writing letters, bookkeeping, desktop publishing, playing games, and surfing the Internet. Therefore, the portion of the computer's cost attributed to patent drawing activities may be relatively low. On the other hand, you may already have all or most of the necessary equipment.

Learning the Software

Each program works in different ways, so we cannot provide specific detailed instructions on how to use a (CAD) drawing program. You must therefore refer to the documentation of your particular program for specific instructions. A drawing program typically comes with a manual that explains all of its functions and usually also offers a tutorial that leads you through training exercises on creating simple drawings. There are enough similarities between most drawing programs that we feel safe in providing some guidelines and examples that are generally applicable to them.

Drawing From Scratch With 2D

If the object you wish to draw does not presently exist, you will have to base the drawing solely on a mental image. Making a drawing from scratch with a drawing program is still much easier than doing it with pens and rulers, because of the large variety of shape-creating and editing tools (functions) provided by most drawing programs.

CAD Terms and Concepts

The following are terms and concepts most often used in the CAD world.

Entities. The individual, basic elements that make up a drawing include lines, curves, text, and so on. Except for text, entities comprise lines connecting spaced-apart points, like a connect-the-dot drawing.

Layers. A layer is an imaginary horizontal slice of an object of any desired thickness. All CAD programs allow a drawing to be separated into different layers. Entire layers may be selected and manipulated at the same time. Layers may be made invisible or visible and may be locked to prevent them from being affected when other layers are manipulated.

Entity Color. Entities can be created in different colors.

Line Types and Widths. Entities can be created in different types, such as continuous and dashed, and different widths, such as 0.1 mm, 0.2 mm, and 0.3 mm.

Snap Grid. This option, when enabled, makes the cursor move only in selectable increments in the vertical and horizontal directions. It is very useful for aligning points with one another and for setting points at precise distances apart with ease.

Cursor Step Size. This is the amount of selectable cursor movement that is possible when moving the cursor with the arrow keys.

Wire Frame. A "see-through" drawing of an object, this resembles a wire frame, so that even lines on the back of the object are visible.

Hidden Lines. Lines that are visible when the drawing is shown in wire frame mode, but would be hidden by other parts of an object if it were shown as a solid.

Available Tools

A typical 2D CAD program includes shape-creating tools. For example, the Box tool can be used to draw a rectangle of any desired size and height-to-width ratio on the screen. Other tools include Circle, Ellipse, Line, Parallel Line, Polygon, and so on. The shapes and lines created by such tools are called "entities," which may be edited (modified) with editing tools such as Point Move, Duplicate, Trim Line, Section Cut, Distort, and so on. The names of editing tools may vary among different programs, but their functions are basically the same. All entities may be created with any desired dimensions.

Entities may be created by selecting a tool and setting points by pressing the mouse button (each press of the button sets one point). For example, as shown in Illustration 3.3, a triangle is created by selecting the Line tool, and setting three points. Set the first point by left-clicking the mouse where this point is desired. Then drag the cursor to create an adjustable straight line that always extends between the point and the cursor, which can be moved to any position to make a line of any length and angle. When you've moved the cursor to the desired location of the end of the line or second point, press the mouse button to set the second point and create the line. Setting two more points creates the triangle (the fourth point is set at the same position as the first point to close the lines). The points may be set at specific distances apart to create a triangle with precise dimensions.

A perfect ellipse may also be created by selecting the Ellipse tool. After setting the first point to define the center, dragging the cursor away from the first point creates an adjustable circle. Positioning the cursor at the desired location and setting the second point defines the major (long) axis, and dragging the cursor away from the second point creates an adjustable ellipse. Positioning the cursor at the desired location and setting the third point defines the minor (short) axis and fixes the ellipse.

Such shape-creating tools enable you to draw perfectly formed shapes and lines without the drawing skills needed for traditional drawing techniques (pens and rulers). The shape and size of the entities may be edited in a variety of ways, such as those shown in Illustration 3.4.

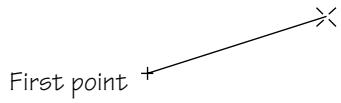
These functions may not be immediately understandable by looking at static drawings in the example illustrations, but they will be once you are in a program and can see interactively what they do.

Making a Drawing

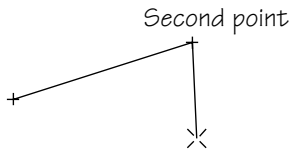
Unlike drawing with a pen, rough sketching is not necessary when drawing with a computer, because a digital drawing may be easily edited. Nevertheless, with a 2D program, you must draw lines and shapes by estimating what they should look like, just as you would when drawing by hand with a pen. As an example, the making of a perspective view of a joystick is shown in Illustration 3.5 and explained here:

1. Create the top of the base by selecting the Box tool and drawing a box.
2. Distort the box with the Distort tool. The amount of distortion must be estimated.
3. Rotate the box with the Rotate tool to make it appear as though it is seen in perspective. The amount of rotation must be estimated.
4. Copy (duplicate) the box and paste it below the original to create the bottom.
5. Draw the vertical sides of the base by selecting the Line tool and drawing three lines.
6. Delete the hidden lines of the lower box with the Trim tool.

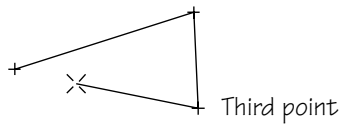
Creating a Triangle



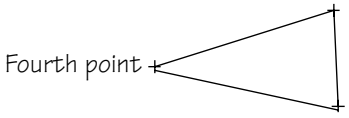
1. Set first point by clicking the mouse to define first corner.



2. Set second point to define second corner.

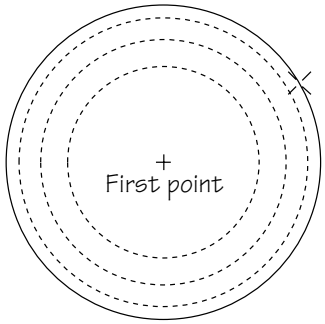


3. Set third point to define third corner.

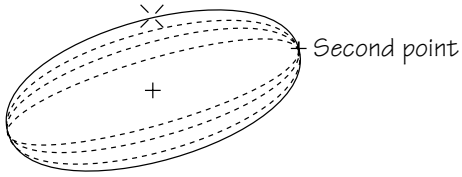


4. Set fourth point at same position as first point to close lines.

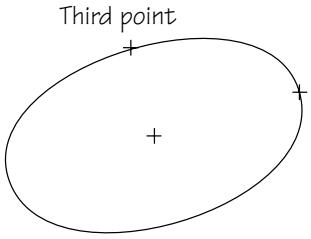
Creating an Ellipse



1. Set first point to define center.



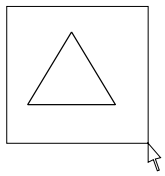
2. Set second point to define major (long) axis.



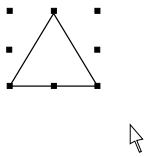
3. Set third point to define minor (short) axis.

Illustration 3.3—Creating an Object

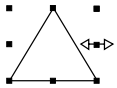
Distorting an Object



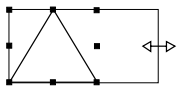
1. Select the object by dragging a "selection box" around it.



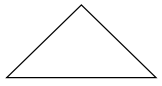
2. Object is surrounded by a "bounding box" with square "handles."



3. Cursor changes shape when positioned on a handle.

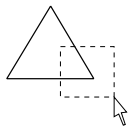


4. Drag handle to new position.



5. Object is distorted.

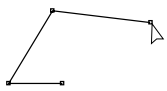
Editing Lines



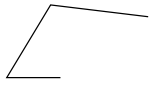
1. Cut part of object with cut off box.

2. Object is cut.

3. Display points on line by using special cursor.



4. Drag point to new position.



5. Line is repositioned.

Illustration 3.4—Editing Objects

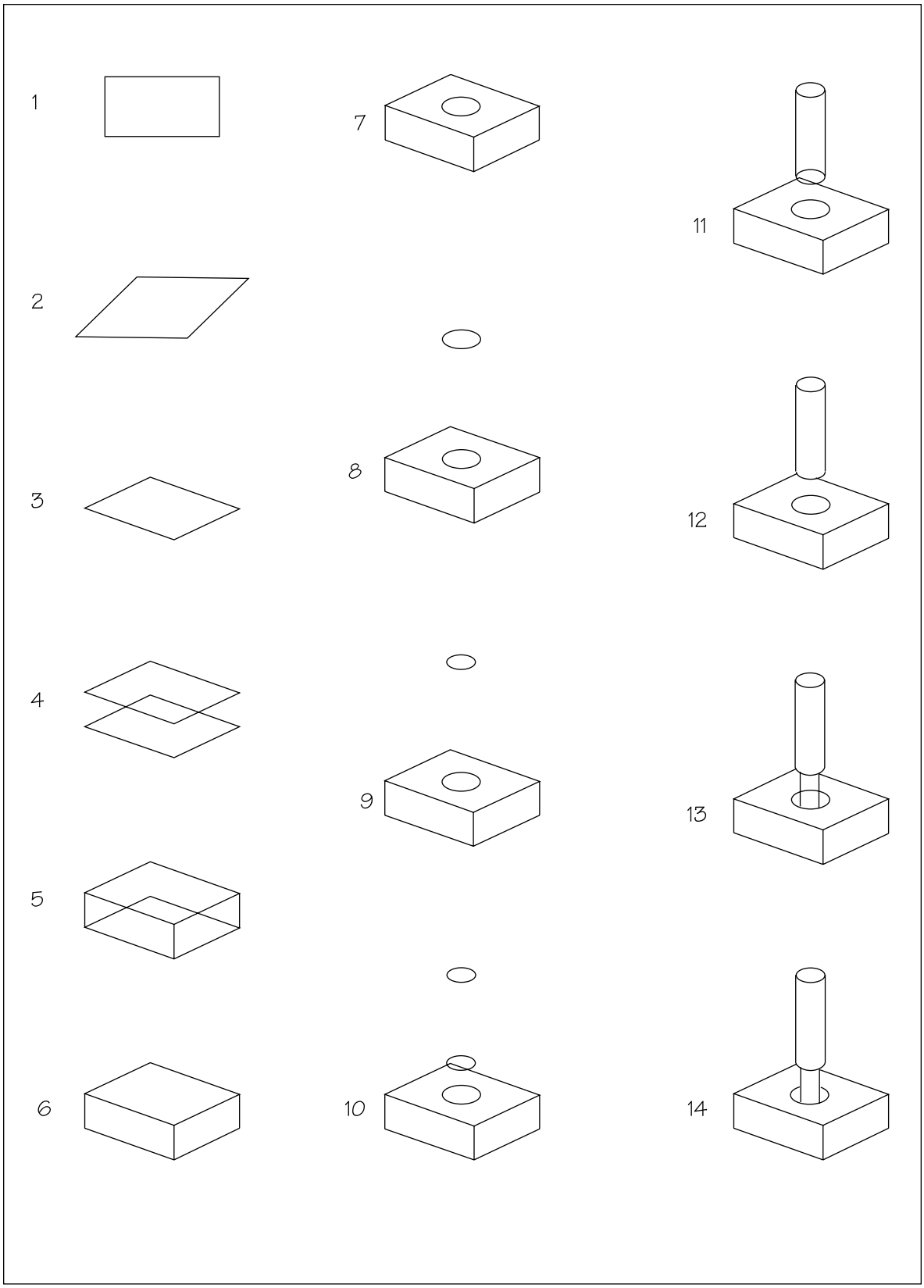


Illustration 3.5—Drawing With 2D CAD

7. Draw an ellipse with the Ellipse tool for the hole on top of the box. Refer to Chapter 2 for details on drawing circles in perspective.
8. Copy the ellipse and paste it above the original along the same centerline, to create the top of the handle.
9. Slightly reduce the size of the handle top with the Scale tool.
10. Copy the handle top, and paste it below the original to make the lower end of the handle.
11. Draw the sides of the handle by selecting the Line tool and drawing two lines.
12. Delete the excess portion of the lower end and the portion of the base behind the handle with the Trim tool.
13. Draw the sides of the connecting rod by selecting the Line tool and drawing two lines.
14. Delete the portion of the hole and box behind the connecting rod with the Trim tool.

The joystick was simply drawn until it "looked about right," without regard to dimensions, because it would have been difficult to determine the dimensions of its lines in perspective. Refer to Chapter 2 for a discussion of the appearance of objects in perspective.

Study Similar Objects for Clues

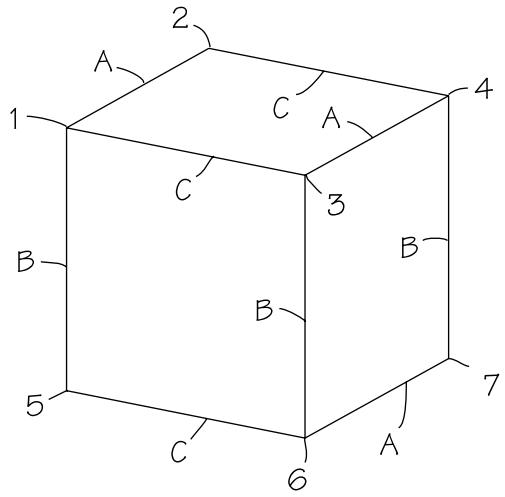
During or after the creation of a drawing, you can easily edit it to achieve the desired result. If you have trouble making the drawing look right, study an object that is shaped similarly to the one you are drawing, or the portion of the object you are drawing. For example, if you have trouble drawing a box in perspective, find a similar box, position it in the same view angle that you are drawing, and study its lines to get an idea of what they should look like, as shown in Illustration 3.6.

When studying the lines, look for qualities such as their angles relative to the vertical or horizontal axes, angles relative to other lines on the same object, and the relative length of each line with respect to other lines on the same object, and so on. If you are careful in making these observations, you should be able to create satisfactory drawings. However, if you are still having difficulty, you may consider either making a model and tracing it or using a 3D program to create an accurate 3D model (both methods are described below).

Patent drawings are not art, but rather technical illustrations, so they do not have to be artistically perfect or beautiful. However, they do have to be reasonably accurate in depicting the structure of the invention. They must also be reasonably well executed—that is, they must be neat, not sloppy or rough.

Page Layout

Each figure (drawing) should be big enough to show all of its details clearly. If several different figures are still small enough, they should be placed on the same sheet of paper to avoid using too many sheets of paper. Page layout is easily accomplished by simply selecting and dragging the figures to desired positions on the page, as shown in Illustration 3.7. Although paper is cheap and printing many sheets is easy, using fewer sheets increases paper handling convenience for you and reduces the amount of page flipping the examiner must do. However, if the figures are too large to fit on one sheet comfortably, use as many additional sheets as necessary; do not crowd the figures.



Note that:
Lines A are about 30 degrees above horizontal and parallel to each other.

Lines B are vertical and parallel to each other.

Lines C are about 10 degrees below horizontal and parallel to each other.

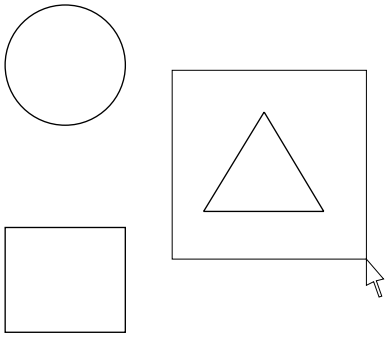
Point 1 is positioned about midway between Points 3 and 4 along the vertical direction.

Point 2 is positioned about midway between Points 1 and 3 along the horizontal direction.

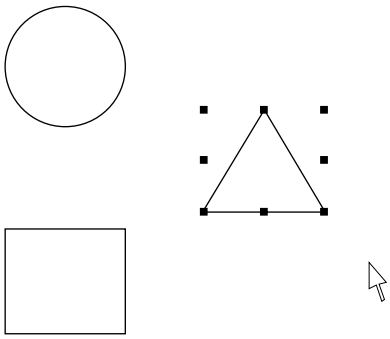
Point 4 is positioned about midway between Points 1 and 2 along the vertical direction.

Point 6 is positioned about midway between Points 2 and 4 along the horizontal direction.

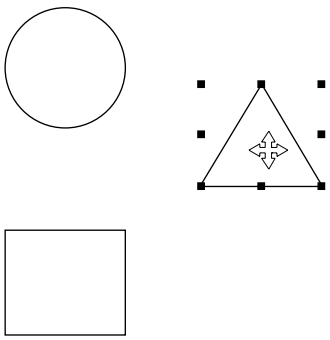
Illustration 3.6—Studying Objects for Clues



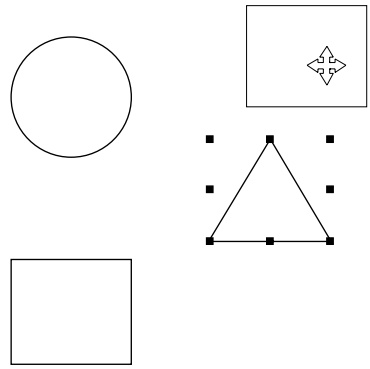
1. Select an object by dragging a "selection box" around it.



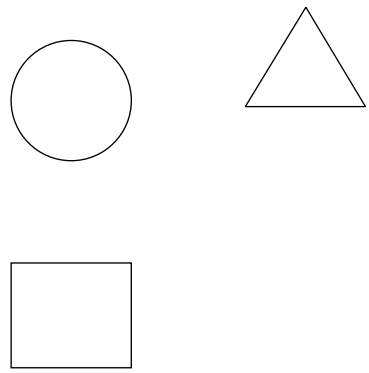
2. Object is surrounded by a "bounding box" with square "handles."



3. Cursor changes shape when positioned in bounding box.



4. Drag box to new position.



5. Object is moved to new position.

Illustration 3.7—Repositioning an Object

General Drawing Tips

Keep in mind:

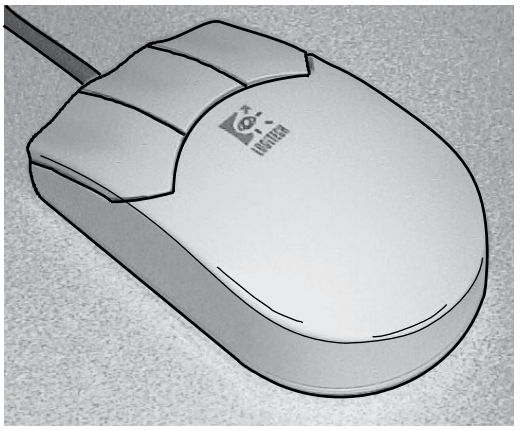
- Use different line widths for different drawing elements. For example, use 0.2 mm or 0.3 mm lines for the object and 0.1 mm or 0.15 mm lines for lead lines and hatching. Refer to Chapters 6 and 7 for more information on line types and widths.
- Use different colors for different line types, so they can be easily distinguished—for example, red for 0.1 mm solid lines, green for 0.2 mm solid lines, yellow for 0.2 mm dashed lines, blue for 0.5 mm solid lines, and cyan for hatching.
- Separate the colors into different layers, so each layer contains lines of the same type and width that can be easily changed by selecting the entire layer and assigning a new type or width to all its lines. After completing the drawing, make all lines black—the PTO does not allow color drawings or black-and-white drawings with lines having different degrees of blackness to be used (unless color is necessary to illustrate the invention properly).
- Select the font (lettering style) before applying the reference numbers. (See Chapter 8 for details on reference numbers.) This is because if you change the font after the numbers are applied, they will shift position and will no longer line up properly with the lead lines. (See Chapter 8 for details on lead lines.) The amount of shifting depends on the fonts used before and after the change.

Making Drawings by Tracing Photos

A very easy way to make a realistic drawing is to trace a photograph of an actual object, such as the prototype of an invention. (Refer to Chapter 4 for tips on how to take good pictures.) The procedure for tracing a photo with a CAD program is generally as follows:

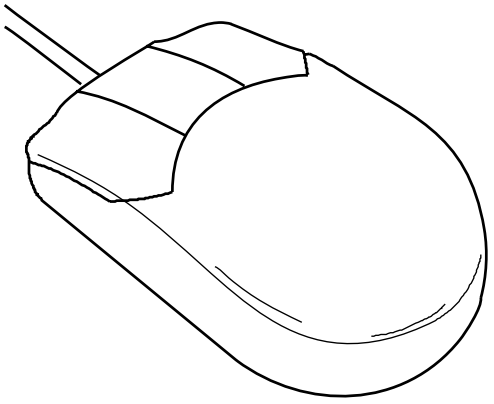
1. Acquire an image of the object by either taking a picture with a digital camera, or taking a picture with a film camera and scanning a photographic print. Cameras and scanners come with their own software for acquiring and handling images. In either case, the picture is saved as an image file on a computer.
2. Import the image into a 2D CAD program. Not all CAD programs can import images, so be sure to select a program with this function. Each program can load specific types of graphics files, for example, BMP, JPG, and TIFF. Therefore, when you save the file after scanning or taking a picture with a digital camera, you must save it in a format that your CAD program can use.
3. Select the Line tool to trace straight lines, or the Curve tool to trace curves, as shown in Illustration 3.8. Zoom in as necessary to see small details better.
4. When you finish tracing, you can either set the image to be invisible and unprintable, or delete it to save disk space, so that only the tracing is visible and printable.
5. Edit the drawing to fine-tune the positioning of the lines and to clean up extraneous lines.

1. Trace straight lines with line tool.



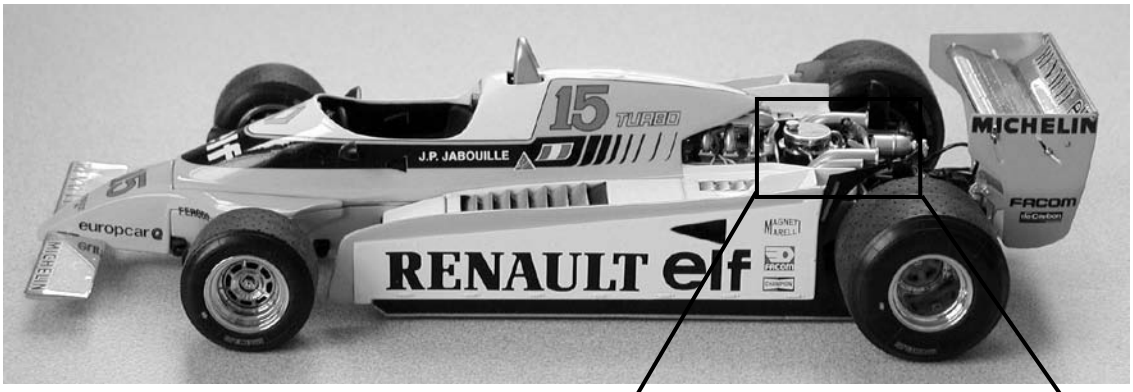
3. Complete tracing.

2. Trace curved lines with curve tool.



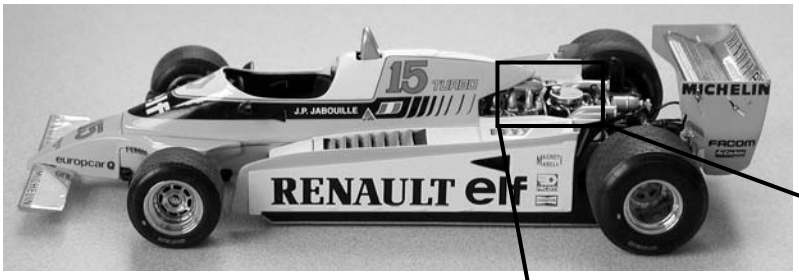
4. Delete image to leave line drawing.

Illustration 3.8—Tracing a Photograph of an Object



3.3 Megapixel Digital Photo

Sharp Details



1.1 Megapixel Digital Photo

Less Sharp Details

Illustration 3.9—Difference Between Digital Photos of Different Resolution

Tracing Tips

Keep in mind:

- Put the tracing and the image on separate layers to prevent them from interfering with each other. Depending upon the program you use, there may be certain procedures that must be followed to ensure that the tracing stays on top of the image instead of being covered by it.
- Use thick lines, such as 0.2 mm to 0.3 mm, for the outline and major features of the object, and thin lines, such as 0.1 mm, for rounded edges and other curved contours.
- Lines representing rounded edges should be broken, and their ends should not touch the outlines of the object. See Illustration 3.8.

Digital Camera Images

A digital camera can transfer its images directly to a computer for tracing, so it is much more convenient than a film camera. The current generation of digital cameras has 3 to 8 megapixel resolution. The best digital cameras have the same effective resolution as 35 mm film prints. Higher resolution images have sharper details, which are easier to trace. (See Illustration 3.9.)

Scanning a Photographic Print

Pictures taken with a film camera must be developed into prints and scanned into a computer with a scanner. A 4" x 6" print should be scanned at 300 to 600 dpi in 24-bit color to produce enough detail for tracing. A 600 dpi scan of the entire 4" x 6" print produces a 9 MB file, which may be too large for some computers to handle with ease. Unless the invention fills the entire print, select only the area to be traced for minimizing the file size and making image processing easier for your computer.

Drawing With 3D CAD

Three-dimensional (3D) modeling is where CAD really shines. As already discussed above, unlike a 2D drawing, a 3D model is a three-dimensional representation of an object in cyberspace (computer space). Such a model is represented by a wire frame, which defines the edges and surfaces of the object. The model may be rotated and zoomed in or out for viewing from any angle or distance desired. Two-dimensional (2D) "snapshots" may be taken from any angle or distance to create different drawing figures. Therefore, by making just one 3D model, many different 2D drawings may be produced with ease.

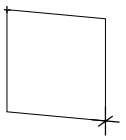
Available Tools and Functions

A typical 3D CAD program includes shape-creating tools, such as Box, Cylinder, Sphere, Cone, Line, and Curve. The entities created by these tools may be modified with editing tools, such as Extrude, Sweep, Drill, Lathe, Slice, Cut Off, Chamfer, and Trim.

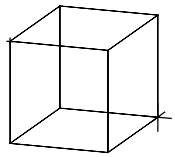
For example, as shown in Illustration 3.10, a box may be created by selecting the Box tool. After setting the first point to define one corner, dragging the cursor creates an adjustable 2D box. Moving the cursor to a position behind the first point and setting the second point defines the diagonally opposite corner and creates the 3D box. Likewise, a sphere can be created by selecting the Sphere tool. After setting the first point to define the center, dragging the cursor creates an adjustable rough outline of the sphere. Setting the second point defines the radius and creates the sphere. Although these objects are treated by the program as solids, they are normally shown on screen as see-through wire frames.

Other standard and nonstandard shapes can also be easily created. As shown in Illustration

Making a Box

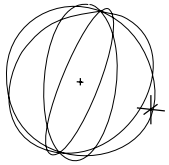


1. Set a point to define first corner.

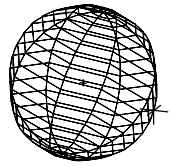


2. Set another point to define opposite corner.

Making a Sphere



1. Set a point to define center.

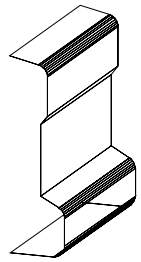


2. Set another point to define radius.

Making an Odd-Shaped Object

1. Create outline.

2. Round off corners with Fillet tool.

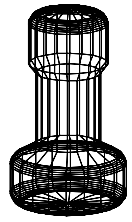


3. Elongate with Extrude tool.

Making an Odd-Shaped Object

1. Create outline.

2. Round off corners with Fillet tool.



3. Make round with Sweep tool.

Illustration 3.10—Some Tools and Functions

3.10, one way to create an irregular shape is by drawing a line or curve and modifying it with tools such as Extrude and Sweep. A great variety of 3D models can be created by combining and modifying different shapes and lines. The complexity of the models you can build is limited only by your imagination and the available tools in a program.

When two or more objects are combined to create more complex shapes, they must be accurately positioned relative to each other. This is achieved by watching the coordinate displays (Illustration 3.2) on the screen to ensure that the points are set in the proper positions. Various functions are also available for ensuring accuracy in point setting and object positioning. Some of these functions include Snap Grid, which confines the cursor to movements of a preset distance, such as 1 mm, and Snap To, which causes a selected entity to snap or stick to a selected position on another object.

Making a Drawing in 3D

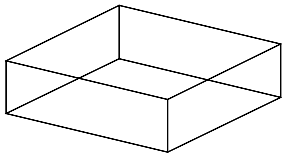
Just as there are many different ways to construct an actual object, there are many different ways to make a 3D model, even when using the same program. These construction methods will become apparent after you have studied the program's manual and gone through the exercises in the tutorial. As an example, the joystick, first drawn in 2D, above, is created in 3D in Illustration 3.11 with the following steps:

1. Make the base. Select the Box tool, set one point to define one corner, and set another point a desired distance away to define diagonally opposite corners of the box.
2. Make a cylinder that extends into the base. Select the Cylinder tool, set one point at the center of the box to define the center of the cylinder, set a second point a desired horizontal distance away to define the radius of the cylinder, and set a third point a desired vertical distance away to define the height of the cylinder.
3. Select the Subtract tool, and select the cylinder and the base. The cylinder will be automatically "subtracted" from the base to create a hole.
4. Select the Cylinder tool, set a point at the bottom of the hole to define the center of the rod, and set two more points at desired positions to define the radius and height of the rod.
5. Select the Line tool and draw a line having desired dimensions above the connecting rod to define half the handle's profile.
6. Select the Fillet tool and set points on the corners of the line to round them off.
7. Sweep the line to create the handle.
8. Select the Fillet tool and set points on the edges of the box to round them off.

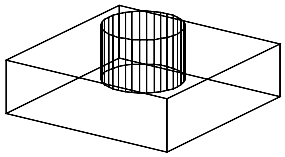
The model can be easily rotated and zoomed to produce a number of different views from different angles and distances, as shown in Illustration 3.12. These views can be saved as individual 2D drawings without the hidden lines (lines that should not be visible because they are behind solid surfaces).

View Distance

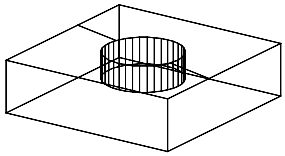
In addition to view angle, the view distance (zoom factor) is typically adjustable in CAD programs. As shown in Illustration 3.13, when the view distance is large, the object appears only slightly distorted—that is, the perspective lines converge very little. At the other extreme, when the view distance is very short, the perspective lines are highly convergent and the object appears very distorted. The most realistic drawing is produced at a moderate view distance. You can easily experiment with the view distance to see what the best setting is for



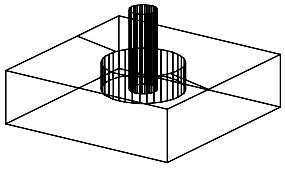
1. Make a box.



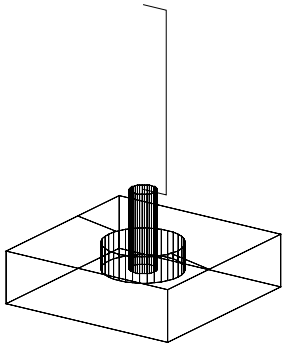
2. Make a cylinder extending into the box.



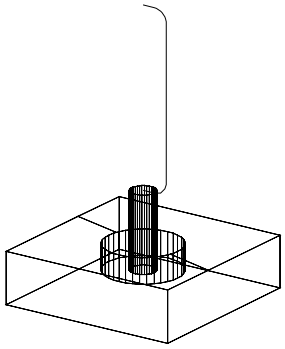
3. Subtract the cylinder from the box to make a hole.



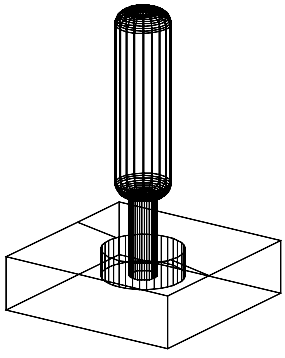
4. Make a cylinder in the hole.



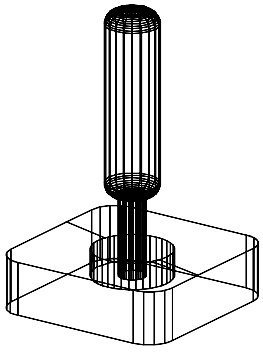
5. Draw a line to define the half profile of the handle.



6. Round the corners.



7. Sweep the half profile to make the handle.



8. Round the edges of the box.

Illustration 3.11—Drawing in 3D

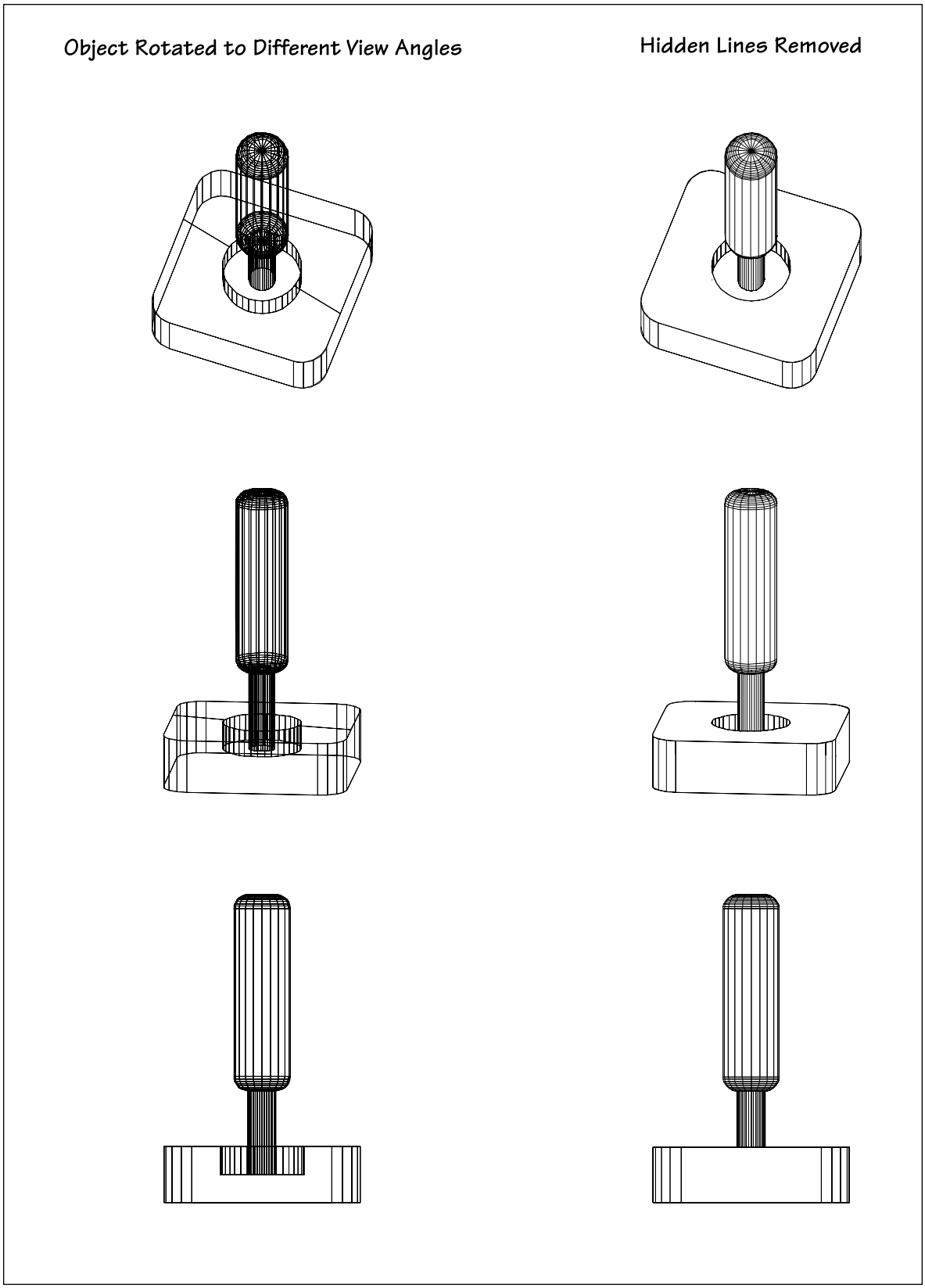
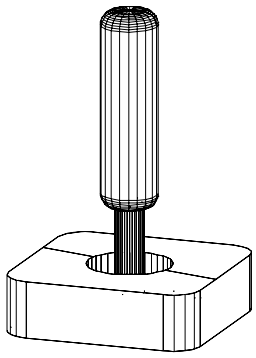
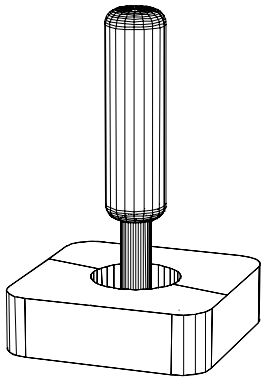


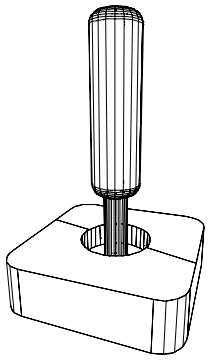
Illustration 3.12—Rotating Object to Obtain Different 2D Views



Large View Distance—Object Appears Slightly Distorted



Moderate View Distance—Object Appears Realistic



Very Short View Distance—Object Appears Distorted

Illustration 3.13—Effect of Zoom on Realism

each particular drawing. View distance in CAD is equivalent to the technique of foreshortening in traditional drawing techniques.

Cleanup

The conversion from 3D to 2D is not always without problems; 2D drawings are often produced with missing or unwanted lines. For example, 3D programs represent curved surfaces, such as cylinders and spheres, with many flat facets. Some programs provide the option of eliminating the facet lines when the model is converted into 2D, but other programs do not. In that case, the facet lines must be deleted manually. Unless you use a combined 2D/3D program, you must import (load) the 3D drawing into a separate 2D program for editing.

TIP

Trace rather than erase. If a drawing has a large number of facet lines, such as a drawing with many spheres and cylinders, it may be easier to trace the lines you want to keep instead of erasing the unwanted ones. Make the original drawing a single color and put it in one layer. Put the tracing on a separate layer, and make it a different color so you can see your progress. After the tracing is finished, delete the original drawing.

Great 2D Drawings for Free

Making a 3D model is different from starting in 2D. However, it is no more difficult than making a single 2D drawing, and provides the significant benefit of allowing you to easily create as many 2D drawings from as many view angles as you wish. Each 2D view is visually accurate.

Shading

A 3D model can be used to produce accurately shaded drawings for a design patent application. See Chapter 7 for a detailed discussion of the technique.

Drawing Graphical Symbols

Two-dimensional (2D) CAD programs may be used to make drawings of graphical symbols, as used in flowcharts and electronic schematics. Some programs come with a variety of types of ready-made symbols—typically electronic symbols—that can be easily arranged to create a drawing. There are also add-on symbol libraries from a variety of vendors. If the symbols you need are not available, you can easily make them from scratch. You need to make each symbol only once; after it is created, it may be easily duplicated as many times as necessary.

There are many ways to make a drawing using graphical symbols. As an example, one way of making an electronic schematic is as follows:

1. Open the drawings of the symbols you need (symbols are typically stored separately in different files). Copy and paste them into one drawing.
2. Arrange a few symbols next to each other and draw the connections between them, as shown in Illustration 3.14.
3. Arrange more symbols next to the first ones and draw the connections between them. Whenever an identical symbol is needed, simply duplicate one already in the drawing by copying and pasting. The orientation of the symbols may be changed by rotating them with the Rotate tool.
4. Repeat as many times as necessary to gradually build up the drawing.

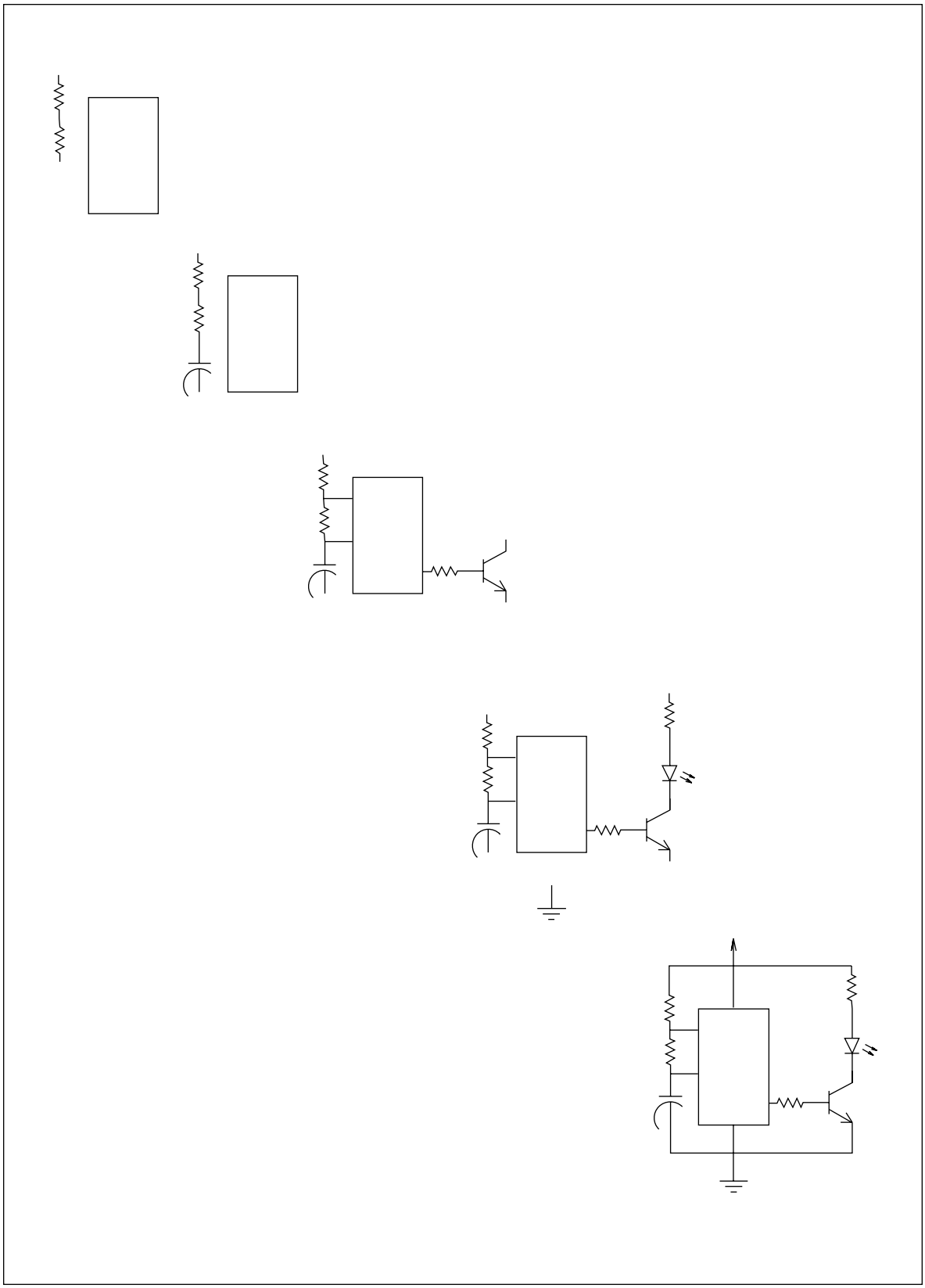


Illustration 3.14—Drawing Graphic Symbols

Retaining Your Drawings

The drawing file should be retained after the application process is finished in case changes to the drawings must be made—for example, if the PTO objects to a drawing, or loses your drawings, or you must make modifications to a drawing, such as correcting a wrong reference numeral. (However, note that you are never permitted to add any "new matter" to a patent drawing.) Also, it is a good idea to back up the file by copying it onto a backup device, so that if you accidentally overwrite or erase it in the computer, it can be restored by copying it back onto the hard drive.

Summary

Making drawings with a computer is relatively easy and fast. Even the most inexpensive drawing programs will enable you to make great-looking drawings without requiring you to have any traditional drawing skills. If you are skilled in traditional drawing techniques and simply wish to modify your drawings with ease, then a 2D program will suffice. However, 3D programs, or combined 2D/3D programs, are so much more powerful that they are well worth the additional expense and effort to buy and learn them.

The functional advantage of CAD over pens and rulers is similar to that of a word processor over a typewriter, but pens and rulers still hold a cost advantage. If you already have a computer, or are planning on buying one anyway, we strongly suggest that you use CAD. Otherwise, traditional drawing techniques are still perfectly viable. Remember, many professional patent drafters still use traditional (pen and ink) techniques.